Senior Design BS Project
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# Force-Feedback System For Laryngoscopy

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## Abstract

During the intubation process, forces greater than 39N applied onto the laryngoscope can cause damage (Carassiti et al., 2012). It may affect: the teeth, vocal cords of patients, perforate the hypopharynx, or cause subcutaneous cervical and facial emphysema (Berry et al., 2013). Currently, there are limited ways to protect the patient's mouth from excessive force. Also, available solutions interfere with the procedure, and don't offer full protection. Therefore, a force transducer that displays the force being generated is beneficial. The objective of this device is to bypass the need for protection by alerting the user of excessive force. When the tongue's soft tissue contacts the sensor on the laryngoscope, the device elicits sensory feedback. The physician can then see how much force he is exerting and adjust accordingly. This system would consist of a 3-D printed adaptor fitted onto a traditional Macintosh laryngoscope blade. Force sensing resistors (FSRs) would be mounted on the adaptor and connected to a feedback circuit that would provide a sensory signal for the users.

## Introduction

Laryngoscopes are devices used for intubation, and to observe the laryngeal area. When forces greater than 39N are applied by technicians, damage may occur in the patients' throat, tongue and teeth. Current devices have no way of measuring the amount of force being generated. Therefore, our project focuses on developing a feedback system to prevent damaging due to laryngoscopy

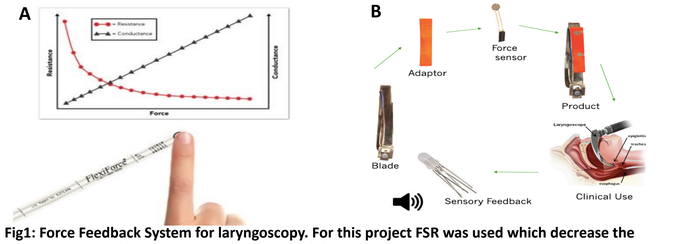


**Fig1: Force Feedback System for laryngoscopy. For this project FSR was used which decrease the resistance as the force applied on it increased (A). FSR mounted onto the 3D adaptor which further connected with the LED. If the force applied by the physician passed 39N threshold, the transducer will provide a sensory feedback in the form of LED and buzzer(B).**

## Methods | Design | Analysis

### Calibration

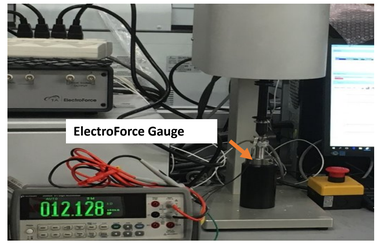


**Fig2:ElectroForce Gauge was used to calibrate the 0-5Kg sensor. The force increased incrementally and the change in resistance was recorded.**

### Adaptor Design

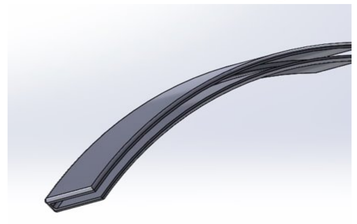

**Fig3: The thin adaptor can easily clip on and off from the laryngoscope. It is single-use, and disposable.**

### Final Prototype

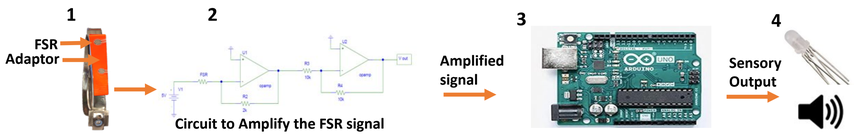


**Fig4: 0-5Kg sensors were mounted onto the adaptor(1). The FSRs were connected to an amplifying circuit(2). The amplified FSR signal was fed to the Arduino, which was connected to an LED and a buzzer(3). The force applied by the user caused resistance changes, which were transformed into sensory feedback (4).**

## Results

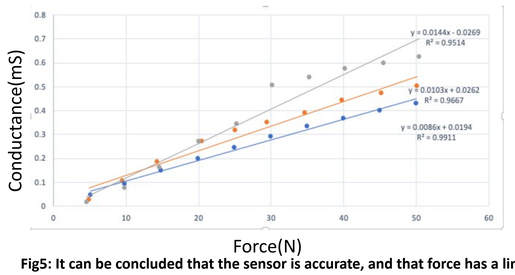


**Fig5: It can be concluded that the sensor is accurate, and that force has a linear relationship with conductance. Force is proportional to conductance, and inversely proportional to resistance. Based on the measurements obtained, this sensor works in our desired range (0-50N) .**

**Fig6: The adaptor does not interfere with the functions of the laryngoscope, fulfilling the design specifications.**

## Conclusion

Research has indicated that 39 N is the threshold for damage. Any exceeding force to an adult without underlying health conditions can lead to adverse effects, such as nerve, teeth and tissue damage. Current laryngoscope models lack feedback systems, which informs healthcare professionals of potential damage they may be inflict. Our device would fill a gap currently seen in the healthcare system globally.

- The chosen sensor for our product can measure the force between 0-50N.
- The 3D designed adaptor is thin and does not affect the intended use of the laryngoscope.
- The feedback transducer informs the user if damaging forces are being applied in the form of a sensory output

## Acknowledgments

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## References

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